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Temperature-dependent exciton dynamics in quantum wells

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Excitons in quantum wells (QWs) suffer from the disorder potential present in QWs due to the interface roughness and also due to compositional fluctuations in the case of alloy QWs. Numerous studies of optical properties of excitons, in particular of the photoluminescence (PL) have been performed with the aim to characterise the disorder and hence the quality of QWs. Theoretical study in this field is however far behind the experimental and technological progress. To describe the PL properties, it is not sufficient to know the energy distribution of localised states for excitons (DOS) because excitons can move between localised states and the energy distribution of recombining excitons does not coincide with their DOS. The exciton dynamics can be strongly influenced by temperature, as has been shown in various experimental studies. This dynamics is especially pronounced in coupled QWs, where excitons have long lifetimes (see, e.g., [1–4]). Two different models have been treated theoretically in order to describe the dynamics of excitons in coupled QWs. In the first model, excitons were considered as single particles and their hopping relaxation has been studied by a computer simulation [5]. In the second model, temperature-dependent recombination of spatially separated electrons and holes has been studied within particular analytical approximations [3]. None of these models is able to account for the whole variety of experimental data related the temperature-dependent PL of excitons in coupled QWs.

In this report, we discuss the relation between experimental results and theoretical models suggested so far for the temperature-dependent energy relaxation and recombination of excitons in coupled QWs. Physical conditions are discussed that favour each class of theoretical models.

References

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